

SECTION 34 21 18

AC SWITCHGEAR

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. AC switchgear
- B. Switchgear housing enclosure
- C. Switchgear enclosure
- D. Circuit breakers
- E. 34.5 KV bus tie disconnect switches
- F. Buses and bus connections
- G. Grounding
- H. 48 Volt DC control power
- I. 120 Volt AC power
- J. Terminations
- K. Equipment protection
- L. Instrument transformers
- M. Fire alarm and smoke detection system
- N. Accessories
- O. Fire extinguishers
- P. Testing

1.02 MEASUREMENT AND PAYMENT

- A. Measurement: AC switchgear will be measured for payment as a lump sum unit acceptably installed and tested for compliance.
- B. Payment: AC switchgear will be paid for at the Contract lump sum price for AC switchgear or as part of the lump sum price for Traction Power Substations, by location, as determined by the lump sum measurement specified above, as indicated in the Bid Schedule of the Bid Form.

1.03 REFERENCES

- A. American National Standards Institute (ANSI)
1. ANSI C37.04 Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 2. ANSI C37.06 Preferred Ratings and Related Required Capabilities for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 3. ANSI C37.09 Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 4. ANSI C37.20.1 Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
 5. ANSI C37.20.2 Metal-Clad and Station-Type Cubicle Switchgear (above 1000V)
 6. ANSI C37.34 Test Code for High Voltage Air Switches
 7. ANSI C37.46 Specifications for Power Fuses and Fuse Disconnecting Switches
 8. ANSI C57.13 Requirements for Instrument Transformers
- B. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
1. ASHRAE Handbook of Fundamentals, Chapter 26
 2. ASHRAE Publication SPCDX (1982, Climatic Data for Region X)
- C. American Society for Testing and Materials (ASTM)
1. ASTM F855 Temporary Grounding Systems to be used on De-Energized Electric Power Lines and Equipment
- D. Illuminating Engineering Society of North America (IES)
1. RP-7 Practice for Industrial Lighting
- E. National Electrical Manufacturers Association (NEMA)
1. NEMA SG4 AC High-Voltage Circuit Breaker
 2. NEMA SG 5 Power Switchgear Assemblies
- F. National Fire Protection Agency (NFPA)
1. NFPA 101 Life Safety Code

1.04 DESCRIPTION

- A. Furnishing and install 34.5 kV ac switchgear assemblies for switching stations, Sectionalizing

stations, and traction power substations.

1.05 SUBMITTALS

- A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples for submittal requirements and procedures.
- B. Product Data: Submit product data for components specified herein.

1.06 SUPPLIER QUALIFICATIONS

- A. Equipment, devices, and components comprising the ac switchgear shall be proven standard products, or equivalent to the standard products of manufacturers engaged in the production of such equipment, devices, and components for at least the past 5 years.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Switchgear Functional Description: The functions of the ac switchgear assembly in each traction power facility are as described below. Where facilities are combined in one location, a common ac switchgear assembly shall be supplied.
 - 1. In switching stations, the 34.5 kV switchgear receives 3-phase, 60 Hz, 3-wire, 34.5 kV power from the 115/34.5 kV high-voltage substation and distributes it by means of two 34.5 kV subtransmission cables to the traction power substations as indicated.
 - 2. In each traction power substation, the 34.5 kV switchgear receives power from the two subtransmission cables and delivers it to the rectifier transformers. A 34.5 kV bus-tie disconnect switch is connected between the load side of the switchgear breakers for isolation of transformer/rectifier units.
 - 3. In sectionalizing stations, the 34.5 kV switchgear divides the 34.5 kV subtransmission system between two adjacent high-voltage substations, and connects the two divided systems during outage of either high-voltage substation.
- B. The switchgear shall be designed and fabricated in accordance with ANSI C37.20.2 and NEMA SG 5.
- C. The ac switchgear shall be housed in an outdoor walk-in type enclosure. The ac switchgear shall include drawout circuit breakers, three-phase bus and bus connections, cable terminations, instrument transformers, indicating devices, protective and auxiliary relays, terminal blocks, control circuitry, interlocks, switches, and all other equipment, panels, and devices as indicated for a complete operating installation. The switchgear for traction power substations shall also include a bus-tie disconnect switch.
- D. The enclosure housing the ac switchgear shall be pre-fabricated, climatized, self-supporting, and transportable. The maximum outside height of the enclosure shall be 12 feet. The maximum headroom shall be 10 feet.
- E. Where shipping splits are required, the assembled enclosure housing shall be made ready for energization by connecting shipping sections of the enclosure, raceways and circuits between

AC SWITCHGEAR

shipping split sections and all control circuits between ac switchgear, transformers, and equipment inside the prefabricated enclosure. Waterproof non-hardening sealing compound shall be used between the foundation and enclosure base perimeter.

- F. Before installations are accepted by the District, the enclosures and floors shall be cleaned, repaired, and re-painted to present the appearance of a new installation.

2.02 OPERATING REQUIREMENTS

- A. All 34.5 kV circuit breakers shall be provided with both local and remote control and monitoring.
- B. At the switching stations, the 34.5 kV circuit breakers shall be normally closed to keep the subtransmission cables energized at all times.
- C. At the sectionalizing stations, the 34.5 kV circuit breakers shall be normally open.
- D. At each traction power substation,
 - 1. One of the two 34.5 kV circuit breakers shall be normally open, while the other circuit breaker shall be normally closed as indicated.
 - 2. Upon loss of power to the substation the breakers shall automatically change positions provided fault conditions do not exist.
 - 3. The 34.5 kV bus tie disconnect switch shall:
 - a. be normally closed, and
 - b. be opened only under no-load condition to isolate one rectifier transformer unit for maintenance.

2.03 RATINGS

- A. Switchgear, disconnect switch, and circuit breaker ratings shall be in accordance with ANSI C37.20 and NEMA SG5 and shall have the following minimum ratings:

1.	Nominal Voltage, Line-to-Line	34.5 kV, rms
2.	Rated Max Voltage	38 kV, rms
3.	Rated Low Frequency Withstand	80 kV, rms
4.	Rated Full Wave Impulse Withstand	150 kV, rms
5.	Rated Frequency	60 Hz
6.	Rated Continuous Current	1200 A, rms
- B. AC circuit breakers shall be in accordance with ANSI C37.06 and NEMA SG4 and shall have the following minimum ratings:

	AC SWITCHGEAR	
1.	Rated Short-Circuit Current at Rated Max kV	21 kA, rms
2.	Breaker Rated Voltage Range Factor, K	1.65
3.	Breaker Rated Interrupting Time	5 cycles
4.	Breaker Rated 3-Sec Short-Time Current Carrying Capability	35 kA, rms
5.	Breaker Rated Closing and Latching Capability	56 kA, rms
6.	Rated Max Voltage	38 kV

2.04 SWITCHGEAR HOUSING ENCLOSURE

A. Enclosure Assembly Construction

1. General
 - a. The ac switchgear shall be housed in an outdoor walk-in weather-proof steel enclosure with minimum service aisle dimensions as indicated.
 - b. The enclosure frame shall utilize steel post-and-beam framing with roof purlins. The enclosure shall be designed for the applicable building code live loads and lateral loads. Roof live load shall be 15 pounds per square foot minimum.
 - c. The floor shall be designed for a uniform live load of 100 pounds per square foot or a concentrated load of 1000 pounds, applied anywhere and distributed over an area of one foot square.
 - d. Where shipping splits are required, additional structural supports and roof beams shall be provided at the splits such that each shipping section is a self-supporting structure.
 - e. All joints, locks and seams, interior and exterior, between panels of wall, floor and roof shall be formed in accordance with the Architectural Sheet Metal Manual, Plates 99 and 100, and shall be caulked with non-hardening compound suitable for indoor and outdoor applications to be compatible with metal finish as recommended by caulking manufacturer.
 - f. Closure plates shall be provided to seal between the foundation slab and the enclosure wall assembly. The closure plates shall be of compatible finish with the walls.
 - g. All exterior steel surfaces including roof, walls and floor shall be hot-dipped galvanized. After assembly, affected areas where welding and cutting has been performed shall be spot galvanized with galvanizing mixture/paint.
 - h. The enclosure shall be weathertight and warranted to be free from defective

materials and workmanship, water leakage and seepage, and condensation. Warranty shall be for a 5-year period.

2. Base Assembly: The base of the enclosure shall be structural steel.
 - a. The main, cross, and longitudinal tie members shall consist of structural steel channels, angles and beams sized as required and braced and joined between shipping splits to provide adequate strength for installation and for operation.
 - b. The base channels shall be suitable for welding to leveling channels that will be embedded in concrete.
 - c. Lifting lugs shall be provided on the base of each complete shipping section. Base structure for each shipping section shall be designed to provide adequate strength for lifting. Other components of the enclosure shall not be permitted for lifting.
3. Floor Plate
 - a. The floor shall consist of a wall-to-wall steel plate, designed to accommodate the layout as indicated and welded to the main, cross and tie channels.
 - b. The thickness of the steel plate shall be determined based on the floor loading, but shall not be less than 1/4-inch.
 - c. Floor openings shall be provided as required and shall be designed to provide access to cable trenches and conduits. Exposed floor openings shall be provided with covers that can withstand equipment weight and traffic.
 - d. Covers for the floor opening to the 34.5 kV trench below shall be non-ferrous. The covers for the floor opening in the 34.5 kV switchgear cable compartment shall have holes, number and location of holes shall be determined and oriented according to the required cable training and termination. The covers shall be split with the split running through the centerline of the holes. After cable and cover installation, the split and holes shall be vermin-proofed.
 - e. The floor for the battery area shall be provided with a containment to retain any electrolyte spill. A durable electrolyte-resistant plastic mat shall be placed on the floor to protect the floor and the curb from electrolyte.
4. Roof Assembly
 - a. The roof shall consist of exterior load-carrying panel members. Assembly shall allow for expansion and contraction and be watertight.
 - b. The outer roof panels shall be a flat seam or standing seam design, fabricated from the same material as the outer wall panels. All seams, splices and roof penetrations shall be formed and flashed in accordance with the Architectural Sheet Metal Manuals. Specific applications and Reference Plates from the Architectural Sheet Metal Manual are as follows:
 - 1) Expansion Batten Seams shall be provided perpendicular to the roof ridge and at connections of the shipping splits. Sections between seams shall not exceed

30 feet in any direction. Form Expansion Batten Seams as shown in Plate 119, Detail 2.

- 2) Eaves at Expansion Batten Seams shall be formed as shown in Plate 103.
- 3) Seams parallel to the roof ridge shall be flashed as shown in Plate 105, Figure B.
- 4) Ridge shall be flashed as shown in Plate 105, Figure C.
- 5) Roof Penetrations shall be flashed as shown in Plate 112.

B. Entry Doors

1. A weather-proof door equipped with standard hardware shall be provided at each end of the aisle. Doors shall be sized to allow removal of a 34.5 kV circuit breaker, and shall be a minimum of 42 inches wide by 96 inches high.
2. The door and frame shall be made of formed sheet steel, 16 gauge minimum, galvanized and shop primed, reinforced to support door closer and panic hardware. Doors shall be insulated in accordance with the climatization requirements specified herein. The door shall be sized to allow removable of the largest breaker.
3. Standard hardware for each door shall consist of the following:
 - a. Heavy duty horizontal exit device, Reed series 3050, a Designated Matching Product, with AF trim exterior handle and RS-34 strike.
 - b. Rim cylinder lock, Falcon #951, a Designated Matching Product, 7-pin standard cylinder, "G" keyway, "O" bitted, US32D finish, furnished with three keys.
 - c. Heavy duty door closer, LCN #4040, Norton E/F, or equal as approved.
 - d. Two pairs of 4-1/2 x 4-1/2 inches, 5-knuckle, concealed bearing, stainless steel hinges with non-removable pins.
 - e. Heavy duty door stop/hold unit to hold the door in a fully opened (180 degrees) position.
 - f. Braided ground strap, 1/2 inch x 14 inches tinned plated copper with 1/4 inch x 1/2 inch stainless steel bolts and nuts installed near the top door hinge for bonding the door to the enclosure frame.

C. Climatization

1. Weather-Strip: Openings such as doors and removable panels shall be provided with weather-strips to exclude water entry under all weather conditions.
2. Thermal Insulation:
 - a. Floor Insulation: Coated, glass-fiber insulation, one inch thick, three pcf minimum density, applied with adhesive and mechanical fasteners to underside of floor

plate.

- b. Wall, Roof and Access Door Insulation: Insulation shall be foil faced glass-fiber, two inches thick, three pcf minimum density with foil face facing interior, sandwiched between the inner and outer panels.

D. Heating and Ventilating System

1. General

- a. The purpose of the heating and ventilating system is to provide heating and cooling for maintaining the enclosure temperature within the minimum and maximum indoor design conditions; to provide relative humidity high limit control; and to ensure that the maximum hydrogen/air mixture (generated during battery charging) is held below a 1 percent hydrogen concentration where there are batteries.
- b. Submit heating and ventilating system engineering calculations for review and approval. The calculations shall be performed by a mechanical engineer registered in California.

2. Design Criteria

- a. Indoor and Outdoor Design Conditions: Indoor temperatures shall not exceed 122°F (50°C) with the fans operating, at their design capacities, while outdoor temperature is 104°F (40°C), indoor temperature shall not drop below 40°F, winter outdoor temperature shall be per ASHRAE Publication SPCDX (1982, Climatic Data for Region X), space relative humidity shall not exceed 55 percent.
- b. Indoor Heat Rate: Indoor heat rate shall include heat emanating from equipment and components based on their nominal ratings and 100 percent loading.
- c. Transmission/Solar Heat Gains: Transmission heat gains through sunlit walls and roof shall be based on CLTD method in accordance with ASHRAE Handbook of Fundamentals, Chapter 26. Assume medium color roof and walls, 95°F outdoor temperature, and long axis oriented in true North-South directions. No credit shall be taken for heat outflow from the enclosure.

3. Ventilation Fans

- a. Capacity: Fans shall be rated to draw in, through louvers, 104°F outdoor air and exhaust not more than 122°F air while removing all internally generated heat and solar heat transmitted into the enclosure housing plus 15 percent extra capacity, as a design safety factor.
- b. Fan type: AMCA certified and labeled roof type, centrifugal with aluminum hub and backward-inclined wheel, belt drive with adjustable pitch motor pulley, heavy gauge spun-aluminum dome housing, complete with disconnect switch, bird screen, and prefabricated heavy gauge roof curb with 2 inches thick, 3 pcf fiberglass insulation adhered to inside walls, gravity type backdraft damper, and neoprene vibration isolation pads for fan mounting.

AC SWITCHGEAR

- c. Location: Locate fans on enclosure wall in front of the switchgear.
 - d. Battery Area Exhaust Fan: Where batteries are required, provide wall mounted exhaust fan, spark-proof construction, direct drive, with gravity type backdraft damper and fan hood two feet above the batteries. The fan shall be interlocked with the battery charger and shall run during battery charging and an adjustable period of time after battery charging is completed. Provide bypass switch, 0 to 2 hours range for override. Select exhaust fan for 500 cfm at 3/8 inch wc static pressure.
 - e. Exterior Finish. Ventilation fan aluminum housing shall be painted with the same paint system and color as the building exterior.
4. Louvers
- a. Sizing: Louvers shall be sized for a face velocity of not more than 300 fpm based on the total capacity of all fans. Free area of louvers shall not be less than 45 percent.
 - b. Quantity and Location: Provide not less than two louvers. Locate louvers in walls, not less than six inches above floor and away from fans to assure good indoor air movement.
 - c. Construction: Inside dimensions of 24 inches square and two inches deep, extruded aluminum 0.064 inches minimum thickness, stepped-up storm-proof design, with expanded aluminum bird screen. Use packed acoustical louvers if required to meet the site acoustical criteria. Louvers shall have tamper-proof screws or bolts to prevent louver removal from the outside.
 - d. Exterior Finish. Painting requirement specified for the ventilation fans shall apply to the louvers.
5. Air Filters. Outdoor air shall be filtered by two inches thick disposable filters, acrylic media, with backing, 80 percent efficient by weight. Filters shall be installed on indoor face of louvers inside access holding frame. Filters shall be supported and held snug and securely fit against the louver opening to ensure air entering the enclosure passes through the filter. A differential pressure indicator across filters shall be provided.
6. Temperature Control. Ventilation fans shall be thermostatically controlled and shall be activated as follows: first fan starts at 90°F, second fan starts at 100°F; and both fans stop when temperature drops to 85°F. Provide a manual bypass switch, located at thermostat, having an adjustable range of 0-4 hours, for simultaneous manual control of the ventilation fans. A room thermostat shall cycle the unit heater operation to maintain indoor temperature above 40°F; unit heaters shall be de-activated when temperature reaches 50°F. Provide a manual bypass switch with timer 0 to 2 hours for manual unit heater operation.
7. Space Relative Humidity (RH) Control
- a. Electric Unit Heaters: Provide each ac switchgear enclosure with UL listed electric unit heaters. Each unit heater to include a direct drive propeller fan, sheaved heating element, and controls. Size the unit heater to assure indoor

AC SWITCHGEAR

relative humidity of not more than 55 percent with incoming outdoor air relative humidity of 100 percent at 25°F dry bulb temperature. The unit heaters' capacity shall be adequate to maintain indoor temperature at or above minimum design temperature.

- b. Relative Humidity Control: Provide space humidistat, set at 50 percent relative humidity, to cycle ON at 50 percent RH and OFF at 45 percent RH. The humidistat shall interlock with the room thermostat controlling the same heating system.

E. Lighting

1. Interior illumination shall be provided on the backside of each switchgear cubicle for use during maintenance work. Lighting shall comply with IES standards and shall be controlled by a switch at each cubicle door. Lamps shall be provided with guards.
2. Exterior lighting shall consist of weatherproof, wall mounted area lighting fixture above each doorway. Fixture shall be a one piece housing/refractor of polycarbonate and be equipped with a 70 watt high pressure sodium lamp and internal photoelectric control. Ballast shall be 120 volt, reactor, high power factor type. Photometrics shall provide a low glare, downward and outward light distribution. Exterior lighting shall have its own circuit controlled by a selector switch with OFF, ON and AUTO positions. In the AUTO position, the lights shall be controlled by a photoelectric cell.
3. Emergency lighting shall be provided with self-contained charger and battery sized for 90-minute operation. The emergency lighting shall be at least one footcandle at any point at the floor level, and shall conform to NFPA 101.
4. Enclosure housing interior lighting shall utilize fluorescent lights, chain-suspended at nine feet above finished floor.
 - a. Fixtures shall be industrial porcelain enamel reflector type with 40 watt rapid start, cool white lamps.
 - b. The average maintained lighting intensity shall not be less than 40 footcandles at floor level. Uniformity ratio shall not exceed three to one.
 - c. The interior lighting shall be controlled by surface-mounted 3-way or 4-way switches of specification grade, located near each entry door.

- F. Receptacle. At least one duplex, 20 ampere, 120 volt, 3-wire, grounded receptacle shall be provided inside near each entry door.

2.05 SWITCHGEAR ENCLOSURE

- A. Switchgear assemblies shall be of the metal-clad type and shall form a line-up of deadfront, freestanding cubicles. Each cubicle shall consist of several compartments to house the circuit breaker, busbar, cables, relays and devices as indicated on Contract documents.
- B. Each cubicle shall be a rigid, self-supporting and self-contained electrically welded or bolted steel structure enclosing all sides and top except openings for specific purposes. The structure shall support equipment under normal and short-circuit conditions.

- C. All panels comprising the switchgear enclosure, including the doors, shall be constructed of sheet steel, not less than No. 11 gauge.
- D. Compartments shall be isolated from one another by grounded barriers of not less than No. 11 gauge sheet steel.
- E. Each cubicle shall have front and rear hinged doors. Rear doors shall be weather-proof. Both the front and rear doors shall have provisions for padlocking.
 - 1. The doors shall support flush and semi-flush mounted devices and not distort from a plane surface in any position. The doors shall be supported by concealed hinges.
 - 2. Each cubicle front hinged door shall have a handle and a mechanical three-point vibration-proof latch for holding it in a closed position.
 - 3. Each cubicle front door shall be provided with a stop to hold the door in the open position, so that devices mounted on this door will not touch the devices mounted on adjacent doors.
 - 4. Doors of the circuit breakers compartments shall be designed to be closed and locked when the breaker is in the CONNECTED, TEST or DISCONNECTED position.
- F. Each breaker cubicle shall be provided with protective shutters which automatically close and cover live high-voltage terminals as the removable breaker element is racked out of the cubicle.
- G. The compartment shall be arranged so that the circuit breakers may be drawn in and out of their housing on wheels along guide ways and make connections to the buses and auxiliary circuits by means of self-aligning, self-coupling primary and secondary disconnecting devices.
- H. Bus compartments shall be rigid framework and shall include, but not be limited to, bus work, connection bars, cable terminal connectors, and bus and cable supports.
- I. For cleaning and inspection, removable cover plates with lifting handles for all bus compartment shall be furnished for access to the bus and cable connections with cables in place. Plates shall be less than 18 by 24 inches and less than 20 lbs each with no sharp edges.
- J. Bottom cable entrance shall be provided for external power and control terminations, unless top entries are shown on the Contract Drawings. Ample space shall be provided for cable pulling, cable termination and performing high potential tests on cables without having to remove the terminations from the compartment.
- K. All items that require inspection, operation or maintenance shall be not higher than 72 inches off the floor and shall be accessible from the front and the rear.
- L. The switchgear cubicle shall contain louvers or mesh openings to provide adequate ventilation and air cooling of the components. Ventilation intake openings shall not be located less than six inches above the floor nor where they would allow entry of debris and dirt.

2.06 CIRCUIT BREAKERS

- A. General

AC SWITCHGEAR

1. The circuit breakers shall be sealed vacuum type and rated in accordance with ANSI C37.04 and ANSI C37.06.
 - a. The circuit breakers shall be 3-pole, single-throw, stored-energy operating type, rated for service on a 3-phase, effectively grounded-neutral (X_0/X_1 less than 3), 60 Hz system at a nominal operating voltage of 34.5 kV line-to-line.
 - b. The circuit breaker control circuits and stored-energy charging motor shall operate from a 48 V dc source.
 - c. Removable breaker elements of the same type and rating shall be completely physically and electrically interchangeable. Removable elements not of the same type or ratings shall not be interchangeable.
 - d. The circuit breakers shall successfully close over a voltage range from 38 V dc to 56 V dc, and trip over a voltage range from 28 V dc to 56 V dc.
2. Circuit breakers shall be designed to interrupt the rated short-circuit current in a sealed vacuum with a separate vacuum chamber for each phase of the circuit breaker.

B. Breaker Positions.

1. Provisions shall be made for moving each breaker to a CONNECTED, TEST and DISCONNECTED position. The three positions shall be clearly marked.
2. In the CONNECTED position, both the primary and secondary disconnecting devices shall be in full contact and the breaker shall be in position for normal operation.
3. In the TEST position, the primary disconnecting devices shall be open and separated by a safe distance to prevent arcing, and the secondary disconnecting devices shall be in full contact.
4. In the DISCONNECTED position, both the primary and secondary disconnecting devices shall be open and separated by a safe distance to prevent arcing. The automatically operated shutters shall cover the exposed part of the bus.

C. Operating Mechanism

1. The circuit breakers shall be operated by a motor-charged, mechanically and electrically trip-free, charged-spring type, non-pumping, stored-energy operating mechanism. Provision shall be included for manual charging of the mechanism. The use of hydraulic or pneumatic operating mechanisms is not acceptable.
2. The operating springs shall be discharged automatically when the breaker is rolled fully into the compartment or is moved into the DISCONNECT position.
3. A spring CHARGE/DISCHARGE indicator shall be visible without opening the compartment door.

D. Withdrawal Mechanism

AC SWITCHGEAR

1. Each switchgear cubicle shall have a cranking or ratcheting device for moving the circuit breaker to and from the CONNECTED, TEST and DISCONNECTED positions.
2. A switch shall be included to disconnect automatically the charging motor circuit during cranking.
3. Guide rails shall ensure alignment of the circuit breaker during insertion and removal. Breaker insertion and withdrawal shall be free of jamming and shall only require an average person to operate.

E. Mechanical Interlocks

1. A mechanical interlock shall be provided on each unit to:
 - a. prevent inserting or disconnecting a closed circuit breaker and
 - b. discharge the stored energy springs prior to circuit breaker removal.
2. Positive stop shall be provided to prevent overtravel of the circuit breaker when moving into the CONNECTED position and the TEST positions.
3. A flag indicator, visible when the cubicle door is closed, shall be provided to indicate when the breaker is in TEST position or in CONNECTED position.

F. Disconnecting Devices

1. Each circuit breaker shall be equipped with primary and secondary disconnecting devices.
2. Entrance to the stationary primary disconnecting contacts shall be automatically covered by a shutter when the circuit breaker is in TEST or DISCONNECTED position.
3. All disconnecting devices shall:
 - a. have silver-plated contact surfaces,
 - b. be located and mounted to maintain alignment, and
 - c. make contact between the stationary contacts in the housing and the circuit breaker terminals.

G. Breaker Controls

1. A control switch shall be provided on each breaker unit for electrical tripping of the breaker in any position, and closing only in the TEST position.
2. Local control of the breaker while in the CONNECTED position shall be from the control switch provided on the substation control and annunciator panel as specified.
3. Each circuit breaker shall be provided with a manually-operated mechanical means for tripping the circuit breaker when in the TEST and CONNECTED positions.

AC SWITCHGEAR

4. All breakers shall be equipped with remote control by the SCADA through the interface terminal cabinet. Remote command shall be able to trip breakers at all times, but shall be able to close only when the LOCAL-REMOTE selector switch is in the REMOTE position.
5. Controls for the 34.5 kV breakers shall be interlocked with the rectifier doors in the traction power substation such that any door opening shall trip the breakers.
6. A minimum of ten electrically separate reversible auxiliary spare contacts shall be provided, in addition to those required for the circuit breaker control circuit.
7. All auxiliary contacts shall be operated by the breaker mechanism in both the CONNECTED and the TEST positions.
8. All auxiliary contacts shall be wired to the terminal blocks.
9. Four-digit operation counter shall be provided to record tripping operations with provisions for resetting the counter to zero.

H. Breaker Status Indications

1. The open and closed status of the breakers shall be indicated, respectively, by green and red lights mounted on the control panels and by mechanical flag indicators.
 - a. The red CLOSED indicating light shall be connected to monitor the continuity of the trip circuit.
 - b. The indicating lights and the mechanical flags shall be visible when the circuit breaker compartment door is closed.
2. Dry contacts connected to the terminal blocks shall be provided for remote indication.

2.07 34.5 kV BUS TIE DISCONNECT SWITCHES

- A. Disconnect switches shall be provided in the ac switchgear for traction power substations as indicated on the Single Line Diagrams.
- B. The disconnect switches shall:
 1. be fixed mounted, no-load, three-pole, single-throw, mechanically operated type in accordance with ANSI C37.46,
 2. be key-interlocked with the two circuit breakers as indicated on the Contract Drawings,
 3. be provided with a warning sign, "DO NOT OPERATE DISCONNECT SWITCH WHEN EITHER BREAKER IS CLOSED" and an instruction sign to describe the operating procedure of the disconnect switch. Both signs shall be permanently affixed to the door next to the switch handle,
 4. have continuous current rating of 600 A,
 5. be rated for 38 kV and 21 kA maximum short circuit current,

6. be provided with a manually-operated mechanical means for opening and closing with position indicators visible through a viewing window for the mechanical operator, and
7. be provided with contacts for local indicating lights and remote indications.

2.08 BUSES AND BUS CONNECTIONS

- A. Buses shall be made of rigid copper bars and shall be of sufficient size to carry the continuous rated current, without exceeding the temperature limits indicated in ANSI C37.20.2. The continuous rating of bus and bus connections shall be 1200 amperes. Buses and bus connections shall be epoxy insulated.
- B. The phase sequence of three-phase assembled buses and primary conductors shall be 1, 2, 3, counting from front to back, top to bottom or left to right as viewed from the breaker operating mechanism side of the switchgear assembly.
- C. The buses shall be supported and braced between each other and to the enclosure with high strength anti-hygroscopic, flame retardant, non-tracking insulators, so that the buses withstand the thermal and mechanical stresses due to maximum short-circuit currents equal to the maximum symmetrical interrupting and 3-second short time current ratings of the circuit breaker protecting the bus.
- D. Bus taps and connections shall be welded or bolted.
 1. All bolted bus connections shall be acid etched and plated with electro-deposited silver after buses have been bent or formed. Bending after the plating process will not be allowed.
 2. Bellville-type washers shall be used in bolted connections.
- E. Bus joints shall be acid-etched and plated with electro-deposited silver. Each joint shall have a conductivity of at least equal to that of the bus bar, and each joint shall be so clamped that no loss of conductivity will occur during the life of the equipment.
- F. Access plates shall permit assembling joints and inspecting all bolted connections after installation of the bus enclosure.

2.09 GROUNDING

- A. A copper ground bus with a symmetrical withstand current rating equal to that of the circuit breaker shall extend throughout the entire length of the switchgear assembly.
- B. Two 9/16 inch diameter holes at 1-3/4 inch centers shall be provided at each end of the bus.
- C. Provide one grounding knob on ground bus and each phase bus for the incoming 34.5 kV cables. The grounding knobs shall be provided with removable insulated caps for the grounding device specified in Article 2.16.F herein.
- D. The frame of each circuit breaker shall be grounded directly through a ground contact shoe at all times, except when the primary disconnecting devices are separated and the shutters closed.

- E. Each cubicle shall be grounded directly to the ground bus. Cubicle doors and panels shall be provided with a flexible copper braid ground strap attached to the structure framing.
- F. At all points of connection between the ground bus and the structure, any nonconductive coatings, such as paint or lacquers shall be removed to ensure good electrical contact.
- G. Ground Test Stations
 - 1. Ground test stations shall be provided along the bottom and inside wall of the enclosure as indicated. Ground test stations shall be interconnected by a copper cable sized at no less than 250 kcmil.
 - 2. Each ground test station shall consist of a copper ground bus, 1/4x2x12 inches

2.10 48 VOLT DC CONTROL POWER

- A. A two-conductor AWG No. 6 or larger, 48 volt dc control bus with 600 volt insulation shall be provided for the full length of each switchgear assembly.
- B. The control bus shall
 - 1. run in a protective raceway,
 - 2. be terminated on a terminal block for connection to the supply source, and
 - 3. be tapped at each cubicle served and extended to the associated circuit breaker.
- C. The dc control power shall be used for all closing and tripping functions and for energizing control, indication, monitoring and protective devices.
- D. Molded-case, thermal magnetic circuit breakers shall be provided to protect each control circuit.
- E. 48 volt dc battery and charger system shall be provided, if indicated in the Contract Drawings. Battery and charger system shall be in accordance with Section 26 33 01, DC Battery System.

2.11 120 VOLT AC POWER

- A. A 120 V ac, 60 Hz, No. 2 AWG or larger 2-wire bus shall be furnished for devices such as heaters, fans, lights, and receptacles.
- B. The ac bus shall:
 - 1. extend for the full length of each switchgear assembly,
 - 2. be terminated on a terminal block for connection to an external power supply, and
 - 3. be tapped to the circuit breakers, protecting the circuits for heaters, fans, lights and receptacles. Lighting circuits shall be independent from other circuits.

2.12 TERMINATIONS

AC SWITCHGEAR

- A. The bus connections for the 34.5 kV single-conductor power cables shall be coordinated with the size of the stress cones, and shall not be located lower than 24 inches above the switchgear floor.
- B. Unless otherwise indicated, power cables shall enter and leave the switchgear at the bottom. Provisions shall be made to accommodate the number of cables indicated.
- C. 34.5 kV power cable terminations shall be by stress cones. Cable connectors with NEMA 2-hole shall be provided for the cable size indicated.
- D. Low voltage terminations shall be as specified in Section 20 70 26, Common Materials and Methods for Electrical Systems.

2.13 EQUIPMENT PROTECTION

- A. Relaying, metering and indicating devices shall be provided as shown on the Contract Drawings, and as specified herein.
- B. Switching Station Protection
 - 1. Phase-directional and ground-directional relays (267, 267N) shall be provided and set to operate for faults on the incoming 34.5 kV cables from the 115/34.5 kV substation and equipment.
 - 2. Phase and ground time overcurrent primary and backup relays (251, 251N, 251-B, 251N-B) shall be provided for each breaker, set to operate for faults on the 34.5 kV subtransmission feeder cables.
 - 3. Undervoltage relays (227) shall be furnished to provide permissive closing of the circuit breakers in adjacent sectionalizing stations and tripping the main breakers.
- C. Sectionalizing Station Protection. Sectionalizing breakers shall be provided with:
 - 1. phase and ground time-overcurrent relays (251, 251N) set to operate for faults on the 34.5 kV subtransmission feeder cables on either side of the circuit breakers, and
 - 2. undervoltage relays (227) with time delay to initiate automatic transfer, and provide selective blocking on manual closing, as indicated on the Contract Drawings.
- D. Traction Power Substation Protection
 - 1. Phase and ground instantaneous and time overcurrent relays (250/251, 250/251N) shall be provided for the 34.5 kV breakers and shall be set to operate for faults in the transformer/rectifier units and the dc switchgear bus.
 - 2. Phase and ground time overcurrent relays (251-B & 251N-B) shall be provided for the 34.5 kV breakers and shall be set to operate on overload considering the duty cycle of the transformer rectifier units.
 - 3. Undervoltage relays (227) with time delay shall be provided to initiate automatic transfer upon loss of power.

2.14 INSTRUMENT TRANSFORMERS

- A. The current transformers shall be dry type, 150 kV BIL, multi-ratio, bushing, toroidal or wound-type with distributed secondary windings and shall conform to ANSI C57.13.
- B. Ratio and phase-angle characteristics of current transformers shall be suitable for the relaying or metering as indicated.
- C. In switching stations and traction power substations, each breaker cubicle shall be provided with two current transformers per phase and shall have provisions for mounting two more. In sectionalizing stations each breaker cubicle shall be provided with one current transformer per phase and shall have provisions for mounting one more.

2.15 FIRE ALARM AND SMOKE DETECTION SYSTEM**A. General**

- 1. A fire alarm and smoke detection system conforming to NFPA 72E shall be provided complete with ionization detectors, dual ion zone module, control panel, end-of-line device, power supplies and all other items of material and equipment required for a complete installation.
- 2. Detectors shall be located at strategic locations to detect smoke and other products of combustion. In addition, smoke detectors shall be provided in each ac switchgear cubicle.
- 3. Fire alarm and smoke detection system design shall conform, wherever applicable, to NFPA 72.
- 4. In traction power substations, the fire alarm and smoke detection system for the switchgear housing enclosure shall form part of the system for the substation facility.

B. Smoke Detectors

- 1. Smoke detectors shall be listed to UL standard 268 and shall be documented compatible with the control equipment to which it is connected. Detectors shall be listed for this purpose by UL. The detectors shall obtain their operating power from the fire alarm panel supervised detection loop. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal to be generated to the control panel.
- 2. The detector head shall be a plug-in unit containing the ionization chamber, associated electronics, and plug-in connector for its mounting plate.
- 3. The detectors shall contain an alarm-indicated LED to signal actuation of the detector.
- 4. A concealed calibrated test feature shall be provided to check the operational integrity of the detection chamber.
 - a. The test feature shall provide a concealed, tamperproof method for testing the detector.
 - b. The generation of actual smoke or the removal of the detector from its mounting

plate will not be required for testing.

C. Dual Ion Zone Module

1. The dual ion zone module shall be interconnected as a system by a plug and harness assembly and shall be operable at the control panel.
2. Each detector line shall consist of a four-wire circuit terminating in an end-of-line resistor at panel.
3. A red LED alarm-indication lamp for each circuit shall be mounted on the face of the module and shall illuminate upon operation of any detector installed in that circuit.
4. A yellow LED trouble-indicating lamp for each circuit, also on the face of the module, shall illuminate if a break occurs in the detection circuit or if a detector line leakage to ground becomes excessive.
5. Two separate contacts shall be provided for annunciation. One contact shall be used for loss of control power, and the other contact shall be used for fire, heat, smoke, or any kind of equipment trouble.

D. Control Panel

1. For switchgear enclosure in traction power substations, the fire alarm panel shall be located in the pre-fabricated substation enclosures. Ac switchgear for switching or sectionalizing stations, located separate from traction power substations, the fire alarm panel shall be located within the ac switchgear enclosure housing.
2. The control panel shall be furnished with
 - a. power supply,
 - b. alarm-operated relay with two normally-open contacts,
 - c. summary trouble-operated relay contacts with two normally-open,
 - d. LED indicators for alarm and trouble,
 - e. contacts to interlock with fans,
 - f. momentary contact switches shall be provided for "Reset" and "Lamp Test", and
 - g. built-in ground detection.
2. All contacts shall be rated 3-ampere, 125-volt dc.

E. Enclosure

1. Dual ion zone module and control panel shall be housed in a NEMA Type 12 enclosure. The enclosure shall be surface-mounted and shall consist of a back box and hinged cover fabricated of heavy gauge sheet steel. The back box shall be finished in flat black enamel and shall contain the Z-brackets on which the controls and modules shall be mounted.

2. The cover shall be mounted with a sag-resistant steel piano hinge, and shall be fitted with a key-locking mechanism. The hinged cover shall contain a full-width horizontal viewing slot to permit visual identification of each row of modules and the control panel.

2.16 ACCESSORIES

- A. Provide the following for each switchgear assembly:
- B. Test cabinet with all necessary equipment for testing the circuit breakers after they have been removed from the cubicle.
- C. One set of fuse tongs or hooksticks, depending on the requirements.
- D. Operating lever for manual closing and opening of circuit breakers.
- E. Test cable for each switchgear assembly to permit operating a circuit breaker when completely removed from its compartment. This cable will be required to connect the control circuits of the compartment to the control circuits of the withdrawn breaker and to operate the breaker without the use of the test cabinet.
- F. One set of wrenches for the primary disconnecting devices of the circuit breaker.
- G. A cable-type grounding device for grounding dead bus of feeder circuits. The device shall be operated by a hot-stick and shall meet ASTM F855 requirements. A wall-mounted storage panel shall be provided for the grounding device and hot-stick.

2.17 FIRE EXTINGUISHERS

- A. A fire extinguisher shall be provided near each entry door, in accordance with the requirements of Section 10 40 00 - Safety Specialties. Fire extinguishers shall be of the carbon dioxide type, 20-pound capacity, and shall be wall-mounted.

PART 3 – EXECUTION

3.01 TESTING

- A. General: Testing shall be performed in accordance with the requirements of Section 01 45 24 - Testing Program Requirements.
- B. Factory Tests
 1. The following design tests shall be performed on one 34.5 kV ac circuit breaker, one bus-tie disconnect switch, and one switchgear assembly:
 - a. All applicable tests identified as design tests in ANSI C37.09 for the circuit breaker.
 - b. All applicable tests identified as design tests in ANSI C37.34 for the bus-tie disconnect switch.
 - c. All applicable tests identified as design tests in ANSI C37.20.2 for the

switchgear assembly.

- d. All control circuits including automatic transfer.
2. The following production tests shall be performed on all 34.5 kV ac circuit breakers, bus-tie disconnect switches and all switchgear assemblies:
 1. All applicable tests identified as Production Tests in ANSI C37.09 for the circuit breakers.
 2. All applicable tests identified as Production Tests in ANSI C37.34 for the bus-tie disconnect switches.
 3. All applicable tests identified as Production Tests in ANSI C37.20.2 for the switchgear assemblies.
 4. All control circuits including automatic transfer.

END OF SECTION 34 21 18